Effect of the microstructure of polypyrrole on the piezoresistivity of flexible CuNWs@PPy aerogels

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Aerogels are open porous materials build by interconnected nanoparticles in a 3D network arrangement. The aerogels research is mainly focused on metal oxides, organic matrix, and carbon-based systems. Gathering incredible properties in a solely material such as extremely high surface area and porosity, as well as very low density, aerogels are suitable for a number of applications in widespread fields such as thermal insulation, drug delivery systems, and more recently in flexible sensors. The latter ones have emerged as promising sensing devices where not only good electrical conductivity and excellent mechanical properties are critical, but also light-weight is a matter. Nowadays, high-performance sensors need to meet large strain response in a wide pressure sensing range which is far to be achieved (e.g. significant sensitivity for wrist pulse detection, and a wide pressure response range, essential for human motion detection) [1,2]. Attempting to come over these drawbacks, the use of semi-conductive polymers or mixtures of conductive fillers and polymer matrices, including carbon nanotubes[1], graphenes[3], conductive polymers[4], and metal nanowires (MNWs)[5] has been investigated. However, yet most of the MNWs-based and carbon-based pressure sensors are unstable upon ambient exposure or difficult to prepare, as well as lack of sensitivity over a broad pressure sensing range.

Here, polypyrrole (PPy) was selected due to its intrinsic mechanical robustness and synthesizing easiness to coat an incipient 3D network of copper nanowires (CuNWs) and thus prepare piezoresistive aerogels, while coaxial CuNWs were used to enhance and modulate the conductivity. The physicochemical properties of the hybrid organic-inorganic flexible aerogels were systematically investigated, and their performance upon different stress conditions was evaluated.

References

1. Yamada, T. *et al.* A stretchable carbon nanotube strain sensor for human-motion detection. *Nat. Nanotechnol.* **6**, 296–301 (2011).

2. Guo, Y. *et al.* A Flexible Wearable Pressure Sensor with Bioinspired Microcrack and Interlocking for Full-Range Human-Machine Interfacing. *Small* **14**, 1803018 (2018).

3. Lou, Z., Chen, S., Wang, L., Jiang, K. & Shen, G. An ultra-sensitive and rapid response speed graphene pressure sensors for electronic skin and health monitoring. *Nano Energy* **23**, 7–14 (2016).

4. Ding, Y., Xu, T., Onyilagha, O., Fong, H. & Zhu, Z. Recent Advances in Flexible and Wearable Pressure Sensors Based on Piezoresistive 3D Monolithic Conductive Sponges. (2019) doi:10.1021/acsami.8b20929.

5. Li, Y., Jiang, C. & Han, W. Extending the pressure sensing range of porous polypyrrole with multiscale microstructures. *Nanoscale* **12**, 2081–2088 (2020).